Appraising status of the Yellowstone grizzly bear population by counting females with cubs-of-the-year

Richard R. Knight, Bonnie M. Blanchard, and L. Lee Eberhardt

The grizzly bear recovery plan uses counts of females with cubs as a recovery parameter. The method is explained here and assessed for use with this large, dispersed mammal.

The grizzly bear (*Ursus arctos horribilis*) in the lower United States was declared threatened in 1975 under the Endangered Species Act of 1973 (16 U.S.C. 1531-1544). According to that Act, the U.S. Fish and Wildlife Service had to prepare a plan to recover populations to levels where the species could be conserved and delisted from its threatened status. The Recovery Plan (U.S. Fish and Wildlife Service 1993) uses counts of distinct females with cubs-of-the-year as a recovery parameter in several grizzly bear ecosystems. The total number of these females is assumed to be the minimum number with cubs born in the current year. To our knowledge, this technique, its methodology, and value as a population indicator have never been adequately explained or discussed. Thus, we describe the methodology and assess its potential for continued use in the Yellowstone ecosystem.

Background

The Interagency Grizzly Bear Study Team (IGBST) was formed in 1973 in response to controversy concerning welfare of the Yellowstone grizzly bear population. The team was given broad objectives: to determine the population dynamics and habitat requirements for that population. At that time, grizzly bear density was thought to be about 1/28 square miles (1/72 km^2; Craighead et al. 1974). Given such a low density of bears, data were virtually impossible to obtain without marking individuals. The IGBST was not allowed to mark bears within Yellowstone National Park until 1975, and then it was permitted only on a limited basis. As a recourse, we annually counted females with cubs-of-the-year (COY) to record quasi-quantitative data on the population. Family groups were thought to be more readily observed because they spend more time in the open during daylight hours than do other bears. Only cubs born in the current year were used because yearling cubs may be weaned in some circumstances, while 2-year-olds may continue to accompany the female in others. Research has since confirmed these hypotheses (Blanchard and Knight 1991). Family groups also have more distinguishing characteristics than single bears, such as number of young, size differentials, and color markings. However, these characteristics can change: litter size can be reduced by mortality, apparent color markings change with growth. Although this process contained subjective criteria, we believed that a minimum number of distinct females with COY could be estimated each year if the criteria were stringent enough. These criteria have evolved since 1975 as we gained more experience with the technique.

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Procedures

Females with COY are judged as belonging to the same family group or different groups by 3 criteria: distance between sightings, family group descriptions, and dates of sightings. Minimum distances for 2 bear groups to be considered distinct is based on our knowledge of annual ranges, travel barriers, and typical movement patterns determined by monitoring >190 radio-marked individuals since 1975. Females with COY had the smallest average annual range (231 km^2, SD = 136 km^2) of any sex and age group in this population (Blanchard and Knight 1991). The upper Grand Canyon of the Yellowstone River from the confluence of Deep Creek to Lower Falls was not crossed by a radio-marked bear during this study and was considered a natural barrier to females with COY. Paved highways were considered an impediment to travel because grizzlies in Yellowstone tended to stay >500 m from roads during spring and >2 km during summer (Mattson et al. 1987).

We described each family group primarily by the size and number of cubs in the litter. Once a female with a specific number of cubs was sighted in an area, no other female with the same number of cubs in that same area was regarded as distinct unless 2 family groups were seen by the same observer on the same day, or by 2 observers at different locations but similar times, or 1 or both of the females were radio-marked. Because of possible cub mortality, no female with fewer cubs was considered distinct in that area unless she was seen on the same day as the first female or unless both were radio-marked. We assumed that we saw all cubs in a litter. During aerial observations, cubs reacted to aircraft by running to the female and remaining at her side, thus making them easy to observe. Observations made close to cover for a limited time were not used if there was doubt about litter size. Ground observers watched the family group long enough to insure that all cubs were seen; observers reported any doubt.

This procedure for distinguishing individual females with litters of different sizes is conservative and straightforward. The criteria for determining distinct females with same size litters was more subjective, based on experience and data from radio-marked bears. For this determination, we considered size of annual ranges, rates of movement, and number of days separating sightings. A movement index was calculated using standard diameters of annual ranges (Harrison 1958) of all radio-marked females (n = 31) with COY monitored from 1 May–31 August throughout the study (Blanchard and Knight 1991). The mean standard diameter for all annual ranges of females with COY was 15 km (SD = 6.7 km). To be conservative, we estimated the average maximum travel distance as twice the standard diameter, or 30 km, and used this distance in judging whether 2 females with litters of the same size were distinct.

Distances separating litters of the same size were combined with other information to arrive at a decision as to whether any 2 observations were distinct families or not. As an example, Table 1 shows a matrix of distances between families with litters judged to be distinct in 1990. There were only 2 litters of 1 COY, and these were 74 km and 2 major topographic divides apart. For litters of 2 COY, 3 pairs were ≤30 km apart. Groups 1 and 19 were observed and filmed by the same experienced observer who judged their combined family characteristics to be distinct. Groups 1 and 22 were judged to be different families based on terrain barriers. Groups 9 and 12 were only 17 km apart but were on opposite sides of the upper Grand Canyon of the Yellowstone.

For litters of 3 COY, 7 family groups were within 30 km of another group of the same size. Groups 8 and 11 were separated by 2 major highways. Groups 11 and 13, 11 and 24, and 20 and 24 were separated by the Grand Canyon of the Yellowstone. Groups 11 and 20 were seen by the same observer on the same day. Groups 13 and 20 were 25 km apart when seen on successive days. Groups 13 and 24 were seen and

Table 1. Matrix of distances (km) between family groups of grizzlies containing 2 and 3 cubs-of-the-year. Left and top margins contain family identification numbers, and the entries in the martrix are distances between pairs of families.

	Distance between crosstabulated grizzly groups (km)						
Group No.	**1**	**7**	**9**	**12**	**17**	**19**	**22**
	Litter size: 2						
7	75						
9	115	85					
12	97	85	17				
17	62	35	110	112			
19	30	47	92	95	35		
22	30	60	72	65	67	37	
23	135	145	77	67	170	145	107
Group No.	**8**	**11**	**13**	**16**	**18**	**20**	
	Litter size: 3						
11	30						
13	37	17					
16	87	55	40				
18	75	65	37	72			
20	30	7	10	60	57		
24	35	7	22	55	70	15	

photographed by the same observer, who judged them to be distinct.

Trend index

A plot of logarithms of the annual totals of distinct family groups (Fig. 1) suggested an increasing trend. The slope of a log-linear regression ($R^2 = 0.41$) indicated a 3.9% annual increase. Confidence limits (95%) obtained by bootstrapping (Efron and Tibishirani 1993) were 2%–6%. These results compared favorably with those of Eberhardt et al. (1994), who estimated a 4.6% increase from reproductive and survival data, with 95% confidence limits of 0–9%.

These counts are influenced by annual fluctuations in food conditions (Picton et al. 1986). In years with relatively poor food conditions, bears range widely and are more readily observed. We examined this relationship by plotting the number of distinct family groups against the mean frequency of sightings of family groups in a given year (Fig. 2). This relationship can be used to adjust the number sighted to a common frequency of sighting (Steel and Torrie 1980), adjusting, in effect, to a common probability of sighting. A log-linear regression of the adjusted data (Fig. 3) suggests a lower rate of increase (2.2%/year). Rates of increase from the 2 sources were compared by the difference between bootstrapped values. In 2,000 bootstraps, 18.5% were less than 0, suggesting that the 2 estimates do not differ.

Implications and interpretation

Numbers of distinct family groups are mainly used to estimate a minimum number of adult females in

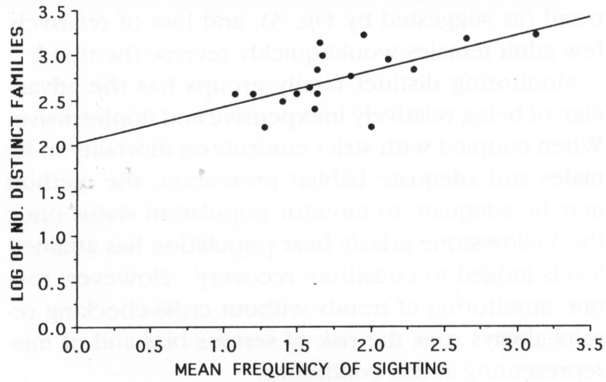

Fig. 2. Number of distinct family groups of grizzly bears plotted against mean frequency of sighting each year, 1976–1993, in the Yellowstone population.

the population. We believe that the estimate of rate of change based on reproductive and survival data is likely to be more reliable than that obtained from trend of the number of distinct family groups. The reproductive and survival data are very important indicators of conditions in the population, providing a great deal more information than trend alone. Agreement between the 2 sources is nonetheless encouraging. Both methods are likely subject to various biases. Confidence limits on the trend index (Fig 1.) appear to be narrower than those reported by Eberhardt et al. (1994) for increases estimated from reproductive and survival data. However, confidence limits on trend indices may be misleading, being much too narrow (Eberhardt and Simmons 1992). We thus believe that conservative view is essential. While an upward trend in population is promising, we could well be overestimating that

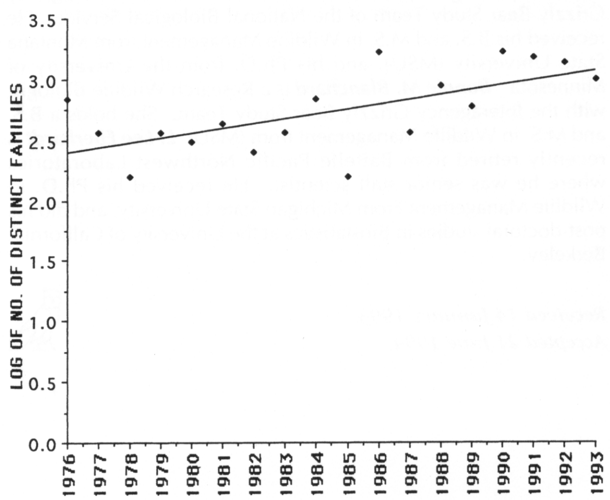

Fig. 1. Log-linear regression of number of distinct family groups of grizzly bears against time in the Yellowstone population, 1976–1993.

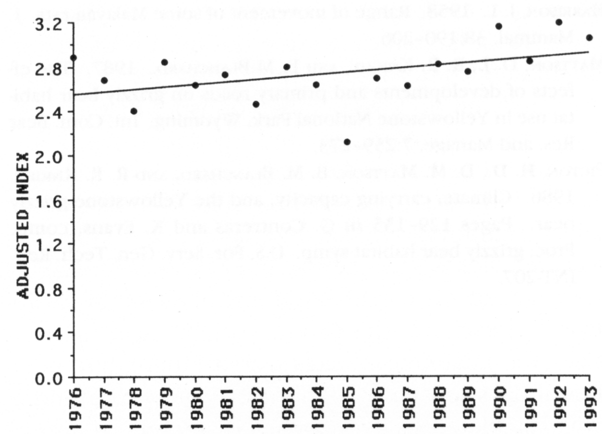

Fig. 3. Log-linear regression of distinct family groups of grizzly bears adjusted to a common mean frequency of sighting during 1976–1993.

trend (as suggested by Fig. 3), and loss of relatively few adult females would quickly reverse the trend.

Monitoring distinct family groups has the advantage of being relatively inexpensive and nonintrusive. When coupled with strict controls on mortality of females and adequate habitat protection, the method may be adequate to monitor population status once the Yellowstone grizzly bear population has attained levels judged to constitute recovery. However, routine monitoring of trends without cross-checking results always runs the risk of serious bias and of misrepresenting actual conditions.

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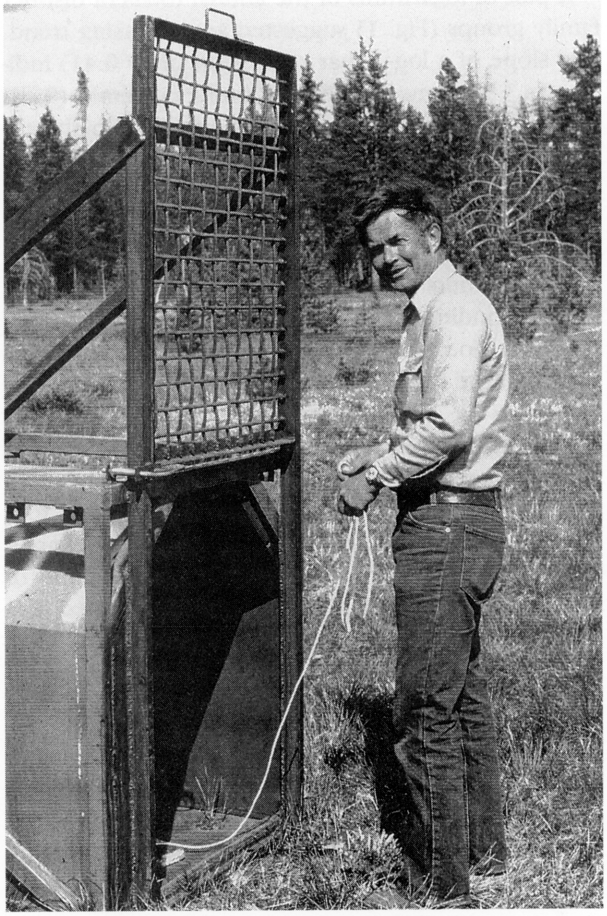

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